

# One-Trial Cardiac Conditioning in Dogs

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**Abstract**—Our interest in cardiovascular conditioning, particularly the fact that conditional tachycardia has been observed in many dogs after only one or two combinations of conditional and unconditional stimuli, led us to investigate conditioning using a single application of an unconditional stimulus. Initially we studied the effect of orienting stimuli (soft tones) on the heart rate in 9 dogs. After 30-100 presentations of the tones alone, each dog received on one occasion a 25-volt shock (sufficient to cause yelping and struggling) to a leg as unconditional stimulus immediately following a tone. Thereafter 30-100 additional tones were presented with no further shock. Little or no heart rate change occurred during the orienting tones (before shock). Three types of cardiac changes occurred during experimental sessions after the shock: 1) Increased heart rate during the tones in 5 dogs; 2) Generalized lowering of heart rate during all experimental sessions after shock in 4 dogs; 3) Electrocardiographic changes during tones in 3 of the dogs also showing the generalized decrease in heart rate. No motor flexion conditional reflexes developed. Tones an octave different in pitch from the one associated with the shock also caused approximately the same heart rate changes, indicating lack of differentiation. This one-trial cardiac conditioning persisted after the single conditioning trial for more than a month in 2 dogs and for at least 3 to 5 sessions in the other dogs.

AT ONE POINT during his study of salivary conditioning in dogs, when a major accident occurred in his laboratory, Pavlov had the opportunity to observe one-trial conditioning. A flood from the Neva River inundated the animal quarters, drowning many of the dogs. Most of those dogs which were saved had been found swimming and had to be removed from their paddocks under unusual circumstances, being herded together with animals unfamiliar to them. After this one episode, Pavlov noted that many of the animals became definitely neurotic. He referred the neurotic behavior to this single episode and considered this to be one-trial conditioning (Pavlov, 1928, p. 364). A similar occurrence was seen by one of us (WHG) in the Pavlovian Laboratory in 1931, when the dogs

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escaped from their paddocks and were forcibly restrained and crowded together in unfamiliar surroundings. Each dog showed a breakdown depending on the type of animal and correlated with conditional reflex stability (Gantt, 1944, pp. 22-28). Since Pavlov did not measure heart rate, he did not have conclusive evidence that conditioning occurs in one trial. However, Pavlov told one of us that the conditional reflex, although not usually seen in the laboratory experiments until after many repetitions, could often be formed by just one occurrence (reinforcement).

In recent years there have been a number of studies dealing with conditioning resulting from a single traumatic experience. Hudson (1950) reported one-trial avoidance conditioning in rats. He used a baited visual pattern from which the rats received a condenser-discharge shock. The avoidance was characterized by the rats' pushing wood shavings toward or making threatening responses toward the visual pattern on occasions subsequent to the shock trial. Maatsch (1959), who studied extinction of an escape conditional reflex (CR) after a single shock, observed no sign of extinction in less than 100 trials in 6 of 8 rats.

Essman and Jarvik (1961) reported one-trial conditioning in mice, using as a measure the latency of the mouse stepping down from a platform to the shelf below. On the conditioning trial the mouse received a shock by stepping down to the shelf. Thereafter, the latency of the stepping response increased markedly.

Willmuth and Peters (1964) found that a single traumatic shock markedly depressed the activity of rats in the environment of the trauma for as long as 6 weeks.

None of the above investigations reported the visceral effects accompanying one-trial conditioning. For a number of years we have studied cardiovascular components of orienting reflexes (OR's) and conditional reflexes (CR's) in dogs. The formation, development, and extinction of cardiac OR's and CR's follow laws somewhat different from those of motor and salivary reactions. Robinson and Gantt (1947) found that a novel (orienting) stimulus may or may not evoke tachycardia depending on its type and intensity as well as on the particular animal. Many dogs show tachycardia which extinguishes on repetition of the stimulus; some dogs show little or no heart rate (HR) change at any time to an orienting stimulus.

Cardiac CR's (HR changes), representing generalized supportive reactions, usually consist of heart rate increases of 10-80 beats/min., which in some dogs develop in one or two trials after beginning reinforcement. These cardiac CR's, once stably formed, are resistant to extinction in contrast to the motor CR's which usually extinguish rapidly (Gantt and Dykman, 1957). This divergence of functioning

of the more specific somatic versus the more generalized visceral systems is termed *schizokinesis* (Gantt, 1953). The persistence of visceral response without reinforcement is probably maladaptive. The facts underlying this concept indicate that plasticity in the higher parts of the nervous system is only partial, allowing rapid development and tenacious nonadaptive persistence of certain activities which may continue after the conditions have changed.

Because of the greater responsivity and conditionability of heart rate compared with motor reactivity in the dog, we attempted to determine whether motor and/or cardiac CR's would develop from only one combination of conditional stimulus (CS) with a painful unconditional stimulus (US), followed by many unreinforced conditional stimuli.

### Procedure

Four mongrel dogs and five beagles were trained to sit quietly in a soundproof room while EKG and respiration were continuously monitored and recorded on a Brush polygraph. At 2 minute intervals tones were presented for seven seconds, 256 cps tones alternating with 512 cps tones, normally 10 trials of each tone per experimental session. These were low intensity tones about equivalent to loud whispers (20 db above the 40 db low frequency air-conditioning sounds of the room). After 30-100 presentations of each tone a one-second shock of 25 volts was given to the left foreleg immediately following one of the 256 cps tones in 5 dogs and immediately following one of the 512 cps in 3 dogs. The shock itself produced yelping and/or struggling in all of the dogs. Subsequently the tones were presented many times on several days with no further shock. Two of the dogs received the single shock inter-trial, rather than immediately following a tone. One of these dogs later received another shock immediately following a tone.

Six-second counts of heart rate were made before, during, and after each tone presentation, averages being taken for each experimental session; then over-all averages from all sessions before the one shock were compared with averages from all sessions after the shock.

### Results

Cardiac reactions to tones before the single shock (orienting reflexes) in most dogs were slight or non-existent. Cardiac reactions appearing after the single shock can be divided into three groups: specific heart rate changes to tones, over-all changes in heart rate level, and occurrence of "dropped beats."

1. *Heart Rate Changes Specifically to Tones.*

Table 1 shows mean heart rates, standard deviations, and t-tests for specific effects of the tones in each dog.

TABLE 1. Specific Effect

Dog	Tone	BEFORE SHOCK					
		Mean HR, Pre-Tone <sup>c</sup>	Mean HR, Tone <sup>d</sup>	Differ- ence	N	S.D. of Diff.	t <sup>g</sup>
Romeo <sup>a</sup>	256*	98.8	100.7	1.9	28	15.41	0.649
	512	97.0	97.3	0.3	29	11.02	0.137
Hawaii	256*	95.3	97.8	2.5	63	16.12	1.221
	512	94.5	100.6	6.1	62	14.71	3.240
Belle	256*	83.0	79.1	-3.9	41	12.20	2.047
	512	81.2	82.1	0.9	39	12.53	0.434
Night	512*	77.2	78.7	1.5	40	14.77	0.641
	256	74.0	80.5	6.5	20	14.96	1.943
Epsilon	256*	97.6	99.4	1.8	50	8.06	1.544
	512	99.7	99.1	-0.6	48	10.12	0.411
Annie	256*	101.1	99.7	-1.4	37	14.75	0.558
	512	101.9	92.2	-9.7	36	15.40	3.788
Delta	512*	77.3	79.6	2.3	88	7.75	2.797
Bernice	512*	98.8	98.1	-0.7	83	9.25	0.700
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Fetchit <sup>b</sup>	256	94.1	89.3	-4.8	54	14.43	2.449
	512	91.8	89.6	-2.2	55	16.06	1.025
Night	512	84.9	86.7	1.8	45	16.55	0.722
	256	80.0	80.0	0.0	22	20.24	0.000

<sup>a</sup> The 8 dogs listed above the dotted line received the single shock immediately after one of the tones of the frequency marked with \*.

<sup>b</sup> The 2 dogs below the dotted line received the shock 60 seconds after one of the tones.

<sup>c</sup> Mean of HR's during the 6-second period immediately before all tones during orienting sessions.

<sup>d</sup> Mean of HR's during all tones during orienting sessions.

<sup>e</sup> Mean of HR's during the 6-second period immediately before all tones during sessions after the shock.

<sup>f</sup> Mean HR's during all tones during sessions after the shock.

<sup>g</sup> This is a t-test of the paired differences, since HR's pre-tone were correlated with HR's during the tones ( $r = .45 - .60$ ).

Dogs 1, 2, 3, and 4 ("Romeo"—male mongrel, "Hawaii"—male mongrel, "Belle"—female beagle, "Night"—female mongrel) showed average heart rate acceleration to tones of 8 to 17 beats/min. for 30-50 trials after the single shock. The 5th dog ("Epsilon"—female beagle) showed cardio-acceleration of only 5 beats/min. during tones after shock, which was nevertheless quite statistically significant. The 6th dog ("Annie"—female beagle) before shock showed deceleration of HR to the 512 cps tones with little change to the 256 cps tones, whereas after the shock to a 256 cps tone the decel-

Heart Rate Changes, Standard Deviations, t-tests.

AFTER SHOCK						
Mean HR, Pre-Tone <sup>a</sup>	Mean HR, Tone <sup>t</sup>	Differ- ence	N	S.D. of Diff.	t <sup>s</sup>	p
96.6	103.0	6.4	33	14.63	2.480	<.02
100.4	109.6	9.2	34	17.05	3.160	<.01
98.1	106.6	8.5	60	16.87	3.926	<.001
94.4	111.6	17.2	62	15.16	8.920	<.001
75.5	85.6	10.1	44	10.19	6.602	<.001
75.3	84.7	9.4	45	8.63	7.335	<.001
88.0	101.7	13.7	40	17.20	5.055	<.001
85.0	98.2	13.2	22	19.12	3.230	<.01
85.4	89.8	4.4	50	9.32	3.321	<.01
84.6	90.2	5.6	52	9.85	4.070	<.001
73.9	63.3	-10.6	36	13.51	4.689	<.001
77.6	73.4	-4.2	38	12.66	2.054	<.05
65.7	64.8	-0.9	99	6.98	1.312	>.05
84.7	85.9	1.2	85	7.61	1.406	>.05
95.6	104.6	9.0	51	15.59	4.112	<.001
96.6	104.0	7.4	51	14.41	3.672	<.001
77.2	78.7	1.5	40	14.77	0.641	>.20
74.0	80.5	6.5	20	14.96	1.943	>.05

eratory effect of the tones was reversed, the striking change occurring to the 256 cps tones. Dogs 7 and 8 "Delta"—female beagle and "Bernice"—female mongrel) showed no HR-change specifically to the tones. Graphs of HR before and after shock are shown in Figure 1.

## 2. "Dropped Beats"

For the purposes of this study we arbitrarily called any sinus pause of the electrocardiogram greater than 1.40 seconds a "dropped beat," whether or not a p-wave was present.

Dogs 5, 6, and 7, two of them siblings, the third being the daughter of one of them, all occasionally showed spontaneous dropped beats before shock. After the single shock to a 256 cps tone, "Epsilon" displayed dropped beats during 15% of 100 256 cps tones and 9% of 100 512 cps tones, the frequency during any particular time period inter-trial being 0-6%. "Delta" showed dropped beats during 9% of 88 tones and 3% of any one control period

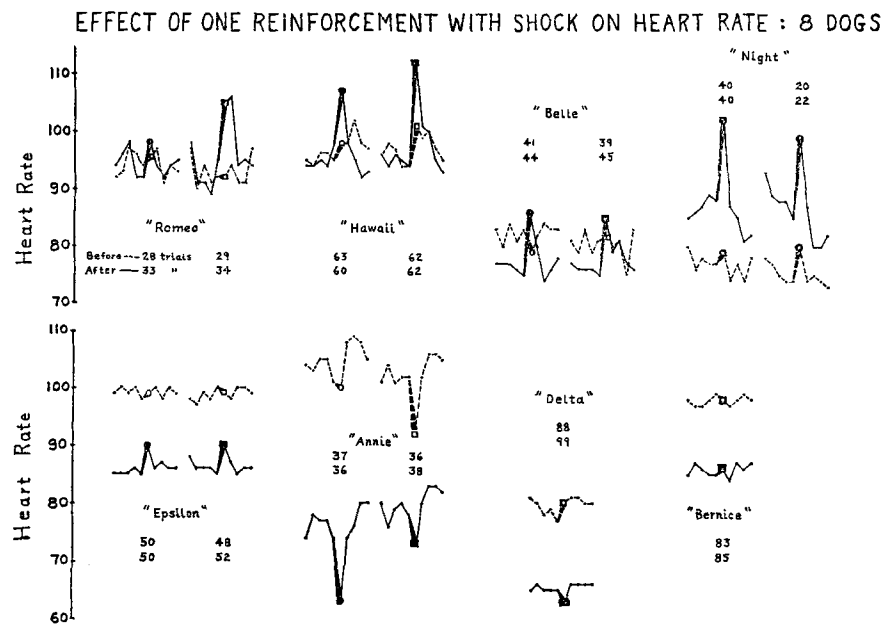


FIG. 1. Over-all average heart rates in 8 dogs during all sessions before (---) and all sessions after (—) a single shock immediately following one of the tones.

Each point on each curve = average of a number of 6-sec counts of heart rate.

○, ● = HR during tones of 256 cps

□, ■ = HR during tones of 512 cps

In all dogs the last of the left-hand tones of "Before Shock" was followed by a shock. Numbers indicate the number of trials of each tone presented before and after shock.

before shock. Subsequent to the shock this dog developed dropped beats during 56% of 99 tones, the frequency during any particular time period inter-trial increasing to only 5-12%. More than half of the dropped beats in this dog consisted of dropped QRS complex with P-wave remaining, which indicates transient blockage of the electrical impulse in the AV-node of the heart (AV Block) (Figs. 2 and 3).

Frequency of dropped beats in "Annie" was difficult to evaluate because of complicating sinus arrhythmia. However, this dog showed definite dropped beats at the onset of tones of both frequencies before shock, the *duration* of the dropped heart cycle(s) being considerably longer during 512 cps tones than during 256 cps tones. After the single shock there was a reversal of the effect of the tones, in that the 256 cps tone (shock was given to one of these) caused a much longer dropped beat than the 512 cps tones (difference significant at .01 level). Usually the first beat after onset of the tone was dropped, but occasionally the dropped beat did not occur until the 2nd or 3rd heart cycle.

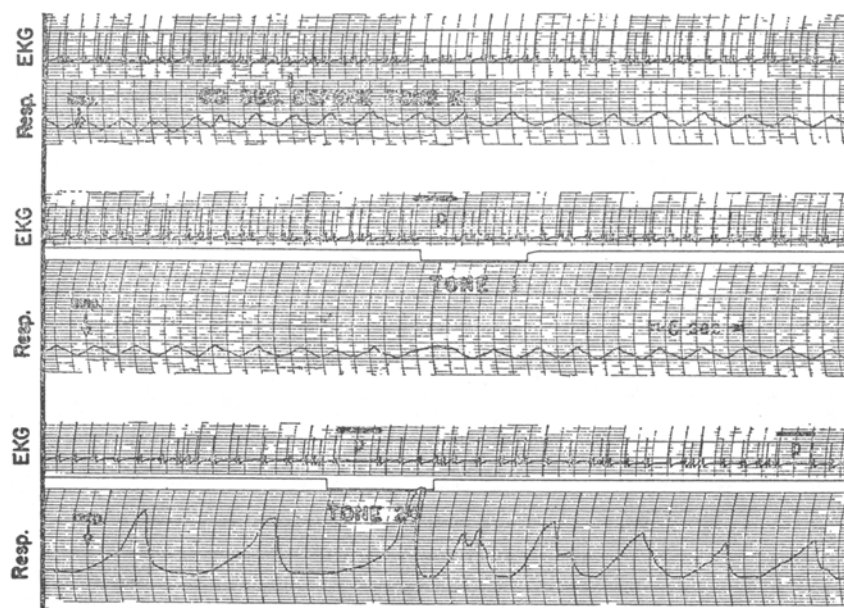


FIG. 2. Sudden dropped QRS with p-wave present (transient AV-block) at onset of conditional stimuli in "Delta." Record of EKG and respiration taken on the 3rd day after a single shock following a tone (60 trials of tones have elapsed prior to tone 1 above). Before any tones are given, no dropped beats occur, but immediately after onset of tone 1 and tone 20 a very prolonged interbeat interval occurs. The presence of the p-wave of the EKG indicated that the impulse is blocked in the AV-node of the heart. A spontaneous dropped beat occurs 23 seconds after the end of tone 20.

### 3. Over-all Changes in Heart Rate Level

Dogs 1, 2, 3, and 4 showed little change in basic level of heart rate after the shock. Dogs 5, 6, 7 and 8, all developed a significant lasting decrease in heart rate level subsequent to the single shock. Three of these were the dogs which also showed dropped beats, and only one of the four developed HR-increase to the tones. Table 2 shows mean heart rates during the six-second period beginning 18 seconds before tone onset for all trials before and all trials after the single shock in these four dogs. As can be seen from the t-tests, the over-all HR-decrease after the shock is significant in all the dogs.

### 4. Persistence of Cardiac Changes

Dogs 3 and 5 ("Belle," "Epsilon") continued to show the HR-increase during tones for 1 to 2 weeks after the one shock (Fig. 4). Dogs which developed over-all HR-decrease continued to show this for at least one week and "Delta" retained a bradycardia for a month after the shock. In addition, "Delta" continued to

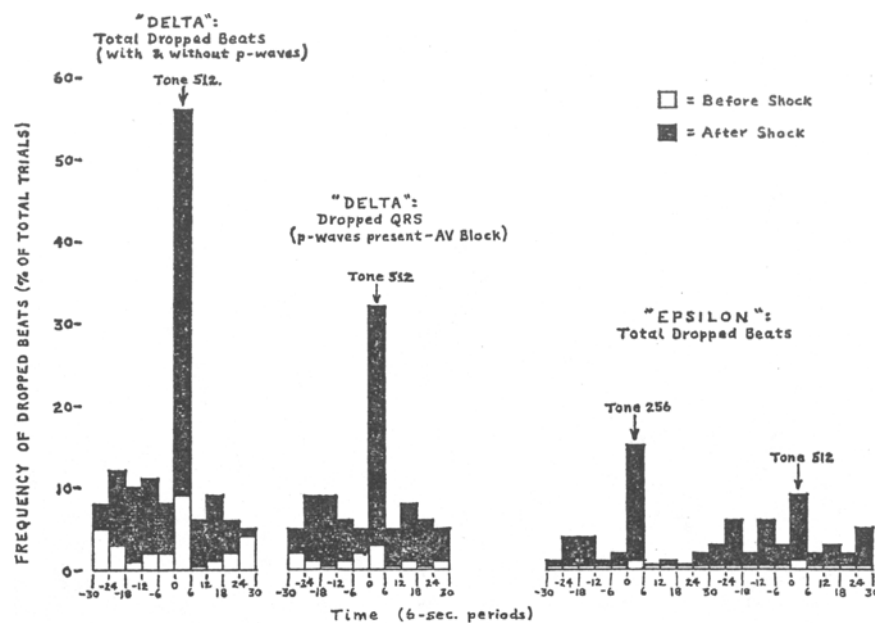


FIG. 3. Percentage of trials on which dropped beats occurred out of the total number of trials given. Each percentage refers to a 6-sec. period of time before, during, or after the tone, allowing only 1 dropped beat per trial during any one time period.

"Delta"—total number of 512 cps tones before shock = 88; total number of 512 cps tones after shock = 99.

"Epsilon"—total number of 256 cps tones before shock = 100; total number of 256 cps tones after shock = 100.

"Epsilon"—total number of 512 cps tones before shock = 100; total number of 512 cps tones after shock = 100.

Shock was given to the last 512 cps tone of "Before Shock" in "Delta" and the last 256 cps tone of "Before Shock" in "Epsilon."

TABLE 2. Generalized (Intertrial) Decrease in HR During Sessions Following One Shock.

Dog	Mean Intertrial HR Before Shock <sup>a</sup>	Mean Intertrial HR After 1 Shock <sup>b</sup>	Difference	df <sup>c</sup>	t <sup>d</sup>	p
Epsilon	98.5	85.2	-13.3	97	6.676	<.001
Annie	104.6	76.9	-27.7	71	6.683	<.001
Delta	78.4	66.4	-12.0	185	6.777	<.001
Bernice	96.6	85.9	-10.7	165	7.379	<.001

<sup>a</sup> Mean of the HR's during the 6-second period ending 12 seconds before tone onset for all tones during orienting sessions.

<sup>b</sup> Mean of the HR's during the 6-second period ending 12 seconds before tone onset for all tones during sessions after the shock.

<sup>c</sup> Df = degrees of freedom = 2N - 2.

<sup>d</sup> This is a t-test of mean differences.

show dropped beats (with and without dropped p-waves) during tones for over one month after the single shock.

### 5. Motor Reactions

In all dogs the single shock caused leg-flexion and signs of distress, such as yelping and struggling. Specific flexion motor responses were rare in all of the dogs after the shock. The number of specific flexion CR's occurring in dogs 1-8 were 3, 3, 0, 5, 2, 0, 3, 0, respectively. However, most of the dogs occasionally showed general restlessness and pacing during tones after shock, some of them often showing trembling. Little or no increase in specific orienting to tones (cocking or turning the head) was observed.

#### CARDIAC CR's NOT EXTINGUISHED 3 DAYS AFTER 1 REINFORCEMENT DOG "BELLE" 1961

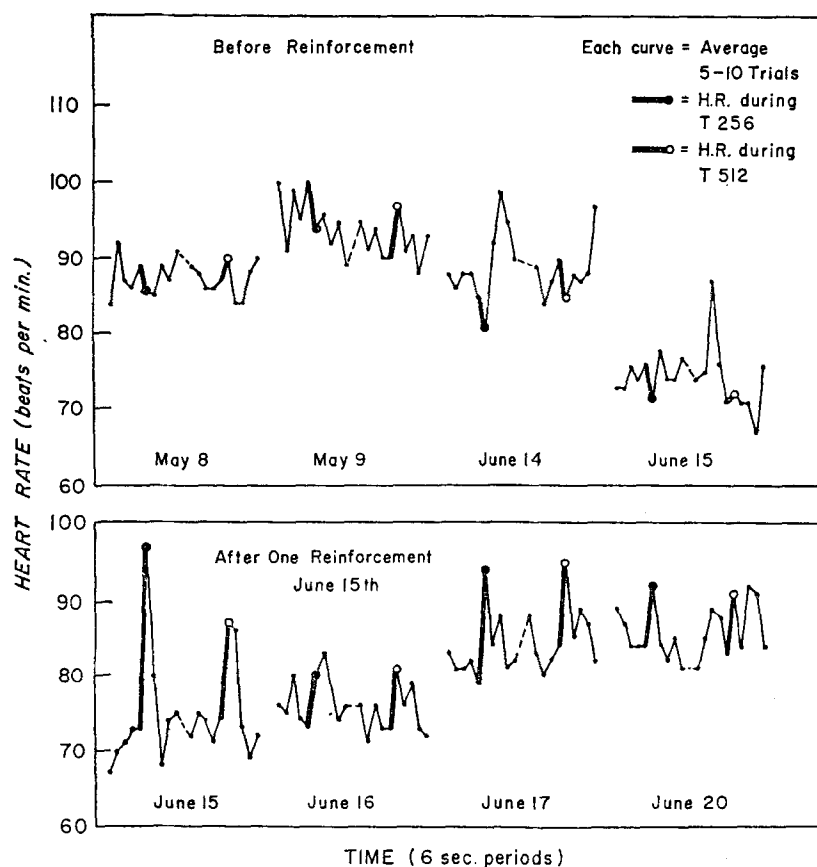


FIG. 4. Daily curves of HR before (upper block) and after (lower block) a single shock in one dog ("Belle"). The last 256 cps tone on June 15, upper block, was followed by the shock, then several more tones were presented that day (June 15, lower block).

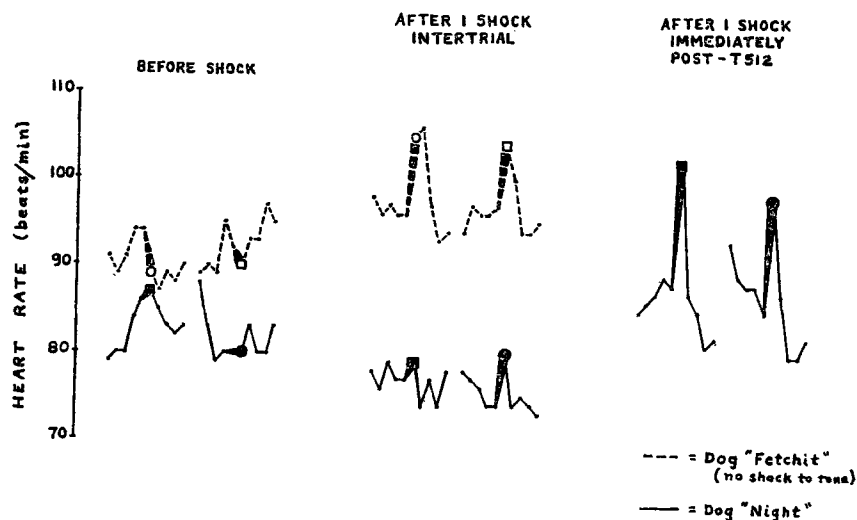


FIG. 5. Comparison of the effect of one shock intertrial with one shock immediately following a tone. "Fetchit" received a single shock approximately half-way between a 512 cps and a 256 cps tone, never receiving a shock immediately following a tone.

"Night" received a single shock half-way between a 512 cps and a 256 cps tone, then after 40 additional trials of 512 cps tones received a shock immediately after a 512 cps tone, the effects of which are shown in the curves on the far right.

Each point on each curve = average of a number of 6-sec counts of heart rate.

O, ● = 256 cps tones;

□, ■ = 512 cps tones.

### 6. Intertrial Shock

Dogs 4 and 9 received the one shock approximately 60 seconds after one of the tones instead of immediately following a tone (Fig. 5).

Dog 4 ("Night") showed a slight over-all decrease in HR and little change in HR to tones after the intertrial shock. Later this dog received another single shock of the same intensity immediately following a 512 cps tone, after which heart rate increased quite definitely during tones.

Dog 9 ("Fetchit"—female beagle), which received the shock only intertrial, developed definite HR-increase to tones, with no specific flexion CR's at any time and only slight restlessness and trembling occasionally.

### Discussion

The data presented here show clearly that a single traumatic experience can have definite effects on the cardiovascular system of dogs, lasting for days and sometimes weeks after the experience. Previously neutral stimuli which become associated with the trauma can elicit thereafter changes in heart rate as well as temporary

changes in the conduction system of the heart in predisposed dogs. It can be argued that the effects which we have observed are not really cardiac conditioning but are instead sensitization, pseudoconditioning, or return of orienting. Since there was little or no HR-increase during orienting tones in most of the dogs, it is difficult to understand how the HR-increase occurring during tones after the shock could be considered reinstatement of the orienting reflex. The lack of heart rate differentiation between the tone associated with shock and the other tone (except in one dog), the over-all HR-decrease in several dogs, and the development of HR-increase to tones after an intertrial shock in one dog are all evidence in favor of sensitization or pseudoconditioning, such as Smith, McFarland and Taylor (1961) have reported.

However, it is significant that, during conditioning to shock in our usual experiments, using 2 conditional stimuli, one always reinforced with shock, the other never reinforced, the early responses to the conditional stimuli *are* diffuse, sensitization-like responses, including marked HR changes to *both* stimuli. Only later are the mass movements replaced by refined, discrete motor responses limited to the reinforced stimuli, with good cardiac and motor differentiation between stimuli. Some of the important effects of *regular* reinforcement with an unconditional stimulus are the refinement and focussing of the behavior and the development of differentiation. With a *single* application of an unconditional stimulus (it is, perhaps, inaccurate to call this a reinforcement), of course, these effects are hardly possible, so that considerable generalization is to be expected. Appropriate to these concepts are Hudson's (1950, p. 143) observations that "The conditioned stimulus to which the animals were responding in the one-trial-learning situation was more than the pattern alone. Experiments with both cats and rats indicate that if the pattern is presented to the animals in a setting different from the one in which the learning trial had been conducted, the avoidance response, if it appeared at all, occurred with reduced intensity. The stimulus, therefore, was not the isolated pattern but the pattern in a rather specific environmental setting."

It is notable that specific motor flexion CR's never occurred in 4 of the dogs and appeared so rarely in the other 5 dogs that they can probably be considered chance movements. Even the mild restlessness and trembling occurring in some of the dogs at times does not seem sufficient to account for the heart rate increases observed, especially since there were tones during which heart rate increased as much as 20 beats/min. with absolutely no observable movement. These observations are strengthened by our own

previous experiments (Newton and Gantt, 1960) showing that the HR-increase to a loud bell as an orienting stimulus is not blocked when the animal is curarized sufficiently to obliterate movements. Black, Carlson and Solomon (1962) have also reported cardiac conditioning in curarized dogs.

Unfortunately, within two weeks after the single shock was given, our follow-up of the effects of the shock was usually terminated by the institution of regular reinforcement with shock. Of the two dogs which were followed for longer periods before beginning regular reinforcement, one continued to show dropped beats for one month post-shock, and the other showed slight HR-increase to tones (8 beats/min.) after a 5 month rest. Our data here are too meager to draw definite conclusions about long-term effects of trauma. Campbell, Sanderson and Laverty (1964), in a study of the effect of a single administration of the curare-like agent succinylcholine in conjunction with a tone as CS, report that GSR-CR's were still present and even stronger in their 5 human subjects three weeks post-drug than one week post-drug. This interesting finding, that the response not only did not extinguish, but also became stronger (as noted by decrease in latency) with time after the trauma, is further evidence for the concept of *autokinesis*, meaning additional development of the effects of past significant experiences in the organism without repetition of the original situation (Gantt, 1953). Solomon and Wynne (1953) have shown similar effects in traumatic avoidance conditioning in dogs with few shocks.

Most people have experienced at one time or another a single severely painful event with subsequent anxiety feelings when confronted later by some of the elements of the situation. Wolpe (1958) relates the history of a patient who developed a fear of anesthetic masks as the result of experiencing a terrifying feeling of suffocation during the administration of an anesthetic. There was a spread of the fear to other stimuli in steps, such that heat and stuffiness in a crowded elevator caused anxiety which later appeared in uncrowded elevators and then in many situations where she could not easily leave at will, such as playing cards. Wolpe (1958, p. 98) says "Anxiety-evoking power is acquired by a new stimulus merely because it happens to be in the environment of the subject in a context favorable to conditioning. For example, a man who already had a conditioned anxiety reaction to the sensation of rapid beating of his heart experienced the onset of an attack of paroxysmal tachycardia just after he had walked to the telephone in his office, while the western sun shone in upon him strongly through the window. After this, he felt tense in sunlight and avoided the sunny side of

the street." The following case histories illustrate the importance of a single traumatic experience in patients seen by another psychiatrist (Teitelbaum, unpublished observations).

1) A 9-year-old girl was in an automobile accident, not physically injured but terribly frightened. For at least 6 weeks after the accident she had terrible nightmares, awakening and screaming, and fears of going to bed alone, irritability, conflict in school, nocturnal enuresis. When riding in a car the child always had to hold onto her mother.

2) A 49-year-old married woman, whose car was hit from the rear on a highway, sustained a mild superficial head injury and back injury with resulting back and hip pain and paresthesia of a leg continuing for over 2 years. When seen by the psychiatrist, she still had frequent headaches, tinnitus, difficulty in hearing. "She has also suffered a post-traumatic emotional disturbance with tension while riding in a car and anxiety about the persistence of her symptoms for so long a period of time. The neurologic examination shows some sensory and motor disturbance in the right leg indicative of injury to the lumbo-sacral spinal nerves on that side. The persistence of her symptoms over two years following her injury makes it likely that there is a strong psychogenic process involved."

3) A 19-year-old boy, whose car was hit in the rear injuring his jaw and straining his neck, lost consciousness briefly. He had headaches, anxiety and depressive feelings, marked tension while riding in an automobile and severe anxiety when passing the site of the accident for over 2 years after the accident. The neurological examination was negative and, "since more than 2 years have elapsed from the time of the injury, further psychiatric study to consider the advisability of psychotherapy is indicated."

4) A 59-year-old man sustained a blow from a heavy magnet, causing a short lapse of consciousness and severe pain. He was hospitalized for one month at complete bed-rest with a steel body brace due to fractures of the body of one vertebra and 3 ribs. Two years later he continued to have considerable residual pain, anxiety, depression, irritability, insomnia and marked tendency to startle. "The neurologic examination does not reveal any evidence of injury to the nervous system. Disability from a psychiatric point-of-view is estimated to be twenty-five percent. Since over two years have elapsed from the time of the injury, the likelihood of further improvement psychiatrically is considered very poor."

These experiences seem to be one-trial conditioning or perhaps one-trial sensitization in humans, showing again the easy development and persistence of disturbances in certain individuals.

Constitutional or personality type undoubtedly plays a role in the individual's mode of reacting to a single traumatic episode, just as this factor does in other behavioral effects. There is an interesting suggestion of this in the various types of cardiovascular responses occurring among the different dogs in this study. We have no ready explanation for the development of the over-all bradycardia in four of the dogs, three of which were beagles related to one another, while the other was a mongrel. Why five dogs (six, if we include the dog which received the intertrial shock) displayed heart rate increase specifically to the tones after shock is also not readily explained on a male-female or genetic basis. Though there was definite overlap among the different types of cardiovascular reactions in the dogs (Dog 5, "Epsilon," showed all three types of reactions), the data in general seem to be fairly clear-cut as to at least two distinct responses: heart rate increase specifically to the tones and over-all bradycardia after the shock. The one definite clue as to familial factors is the appearance of dropped beats in the three beagles from the same family. None of the other dogs showed these effects. There seems to have been a predisposition to dropped beats in this one family. Perhaps the investigations on behavioral differences among true-bred stable and unstable dogs by Dykman and Murphree (1966) will shed some light on these problems.

The possible value of variations in cardiovascular reactions during one-trial conditioning for predicting variations in reactions during conditioning with constant reinforcement awaits future investigation. In whatever way one chooses to interpret these cardiovascular changes which persisted after a single unconditional stimulus, whether as one-trial cardiac conditioning or as sensitization effects, by whatever *name* one might choose to designate them, they were at any rate significant effects which imply that the emotional processes of the animals underwent considerable prolonged disturbances.

### References

- Black, A. H., Carlson, N. J., and Solomon, R. L.: Exploratory studies of the conditioning of autonomic responses in curarized dogs. *Psychol. Monogr.*, **76**:29, 1962.
- Campbell, Dugal, Sanderson, R. E., and Laverty, S. G.: Characteristics of a conditioned response in human subjects during extinction trials following a single traumatic conditioning trial. *J. Abnorm. & Soc. Psychol.*, **68**: 627-639, 1964.
- Dykman, R. A., Murphree, O. D., and Ackerman, P. T.: Litter patterns in the offspring of nervous and stable dogs: II. Autonomic and motor conditioning. *J. Nerv. Ment. Dis.*, **141**:419-431, 1966.

- Essman, Walter B., and Jarvik, Murray E.: Extinction of a response conditioned in a single trial. *Psychol. Rep.*, 8:311-312, 1961.
- Gantt, W. Horsley: *Experimental Basis for Neurotic Behavior*. New York, Paul B. Hoeber, Inc., 1944.
- Gantt, W. Horsley: Principles of nervous breakdown—Schizokinesis and Autokinesis. *Ann. N. Y. Acad. Sc.*, 56:143-163, 1953.
- Gantt, W. Horsley, and Dykman, Ross A.: Experimental psychogenic tachycardia. In: Hoch, P. H., and Zubin, J. (Eds.) *Experimental Psychopathology*, New York, Grune and Stratton, Inc., 1957, pp. 12-19.
- Hudson, Bradford B.: One-trial learning in the domestic rat. *Genet. Psychol. Monogr.*, 41:99-145, 1950.
- Maatsch, Jack L.: Learning and fixation after a single shock trial. *J. Comp. Physiol. Psychol.*, 52:408-410, 1959.
- Newton, J. E. O., and Gantt, W. H.: Curare reveals central rather than peripheral factor determining cardiac orienting reflex. *Amer. J. Physiol.*, 199: 978-980, 1960.
- Pavlov, I. P.: *Lectures on Conditioned Reflexes*, trans. by W. Horsley Gantt, New York, International Publishers, 1928.
- Robinson, J., and Gantt, W. H.: The Orienting Reflex (questioning reaction): Cardiac, respiratory, salivary and motor components. *Bull. Johns Hopkins Hosp.*, 80:231-253, 1947.
- Smith, O. A., Jr., McFarland, W. L., and Taylor, E.: Performance in a shock avoidance conditioning situation interpreted as pseudoconditioning. *J. Comp. Physiol. Psychol.* 54:154-157, 1961.
- Solomon, R. L., and Wynne, L. C.: Traumatic avoidance learning: Acquisition in normal dogs. *Psychol. Monogr.*, 67:(4, whole no. 354), 1953.
- Teitelbaum, H. A.: Unpublished observations.
- Willmuth, Ragon, and Peters, John E.: Recovery from traumatic experience in rats: Specific "treatment" vs. passage of time. *Behav. Res. Ther.*, 2:111-116, 1964.
- Wolpe, Joseph: *Psychotherapy by Reciprocal Inhibition*, California, Stanford University Press, 1958.